Mine Burial Assessment State-Of-The Art Technology Inprediction And Modeling

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LONG-TERM GOAL

The U.S. Navy's mine warfare community requires reliable predictive capabilities for mine burial in coastal environments. Present-day state-of-the-art mine burial prediction capabilities do not adequately meet Navy requirements. Therefore, the long-term goal is to create capabilities that do, in fact, satisfy those requirements.

The ability to predict the rate (speed) and extent of burial of a given type of mine is largely a matter of having mine burial models that realistically emulate the burial environment and incorporate the appropriate burial processes and mechanisms that act on the mine. However, to perform their functions, such models require appropriate input data of commensurate comprehensiveness and precision.

Clearly, it is crucial that such models have available high-quality quantitative input describing pertinent environmental processes and mechanisms and their seasonal variations, and an accurate map of the geological materials. In particular, if they are to achieve the required reliability, the models must incorporate the effects of combined interactions of coupled processes and mechanisms. These processes and mechanisms must be understood and quantified as functions of the dominant environmental forcing mechanisms prevailing in each of the specific coastal environments under consideration. In view of the last consideration, it is also clear that a representative statistical distribution of the geological material properties must be delineated (Bennett, *et al.*, 1992).

The problems that must be solved before the long-term goal is realized are fairly well-known. However, their solution often is not obvious. Furthermore, many of the solutions that may seem obvious are handicapped by lack of pertinent information. Of special note, the labors of numerous workers in the disparate fields of research involved in attaining the goal are independent activities, not necessarily presently oriented toward an integrated attack on the ultimate problem. Actually, the full suite of expertise of individual researchers is often not employed. Consequently, talent goes unexploited, and gaps in capabilities go undisclosed. A detailed assessment and tabulation of expertise, areas of applicable researches, and gaps in both, together with a list of clearly identified operational and field data requirements is crucial to providing a comprehensive overview that enables program managers to formulate plans that optimize achievement of solutions and integrate areas of expertise.

Report Documentation Page

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OBJECTIVES

Succinctly stated, the ultimate goal of creating mine burial models that work reliably requires that several aspects of the overall problem be addressed separately, then collectively, and eventually synthesized into the desired models. To achieve this goal, several objectives will have to be reached. These include the following:

1. Identify preeminent national and international experts in areas of research pertinent to mine burial and in operational mine warfare. Query both communities as to their current and past activities and products and solicit their perceptions of what is now available and what is lacking or desirable. Determine their interest in, and availability for work in areas applicable to mine burial prediction. Compile their input into an assessment of the current state-of-the-art in both the research and the operational communities.

2. Hold an FY-2000 workshop involving these national and international experts with the objective of displaying the spectrum of available expertise, identifying gaps in that spectrum, reviewing current and past applicable activities, suggesting future researches, and in particular promoting constructive interactions among these experts directed toward improving mine burial prediction and modeling. Compare research deficiencies with field-tested and verified operational needs. Use the outcomes of the workshop to modify and augment the review-based assessments.

3. Use the information revealed by the assessment and workshop to formulate and report a prioritized agenda for future work, modified in light of what capabilities currently exist, what has been done but has not been exploited or incorporated into models or data bases, and what capabilities need to be developed to fill the deficiencies and foster enhancements and further developments.

4. Compile a suite of information that will provide the Navy's program managers with a reliable, comprehensive overview enabling them to formulate a cohesive set of research plans that optimize effectiveness.

It is extremely important for future Naval operations to assess the existing state-of-the-art in mine burial prediction and modeling. Obviously, the first objective must be to orient the ONR managers involved in mine burial as to exactly where the capability stands today. It is also extremely important that this overview not be limited to the USA. The assessment must also review all information available from both national and international sources concerning technology currently used in both the USA and other countries active in mine burial prediction.

Review of the collective information will clearly enumerate the positive aspects and capabilities inherent in the current state-of-the-art and, perhaps even more important, identify deficiencies in present predictive techniques. However, a somewhat disturbing possibility here is that the mine warfare community may not, in fact, know exactly what it actually needs. The proposed workshop, involving face-to-face interactions of recognized world experts in pertinent soil and hydrological sciences and experts in the operational employment of the technology, will elucidate many of the requirements and problems. It will provide a unique opportunity for a collective, symbiotic attack on the problems now faced or anticipated. Researchers can critically review the *status quo* and identify, at least tentatively, the most promising approaches and the kinds of technical expertise required to improve qualitatively and quantitatively the mine burial predictive capabilities for seafloor geological materials in coastal environments.

Since quantitative predictive modeling of mine burial requires not only realistic numerical models that include the major or dominating active mechanisms but also an accurate knowledge of the input parameters (e.g. range or statistical base of numerical values), it will undoubtedly be necessary to synthesize new methodologies appropriate to the problems. Because of the complex coupled processes and interactive mechanisms involved in mine burial, this will be a non trivial problem, but a through review, reevaluation, and analysis of the present state-of-the-art in mine burial technology will significantly enhance our future ability to reliably and quantitatively predict the fate of objects on the seafloor.

APPROACH

Based on the above considerations, the initial approach necessary for achieving the objectives of the proposed work breaks down to performing two principal tasks, along with any necessary subtasks:

Task 1 is the Review of the Mine Burial Technology.
Task 2 is a Workshop on Mine Burial.

Steps, or subtasks, involved in conduct of the two Tasks are reiterated below.

TASK 1   Review of the Mine Burial Technology

A. Literature searches, source material identification
B. Identification of countries and agencies active in mine burial
C. Meetings with technical representatives from the countries and agencies active in mine burial
D. Compilation of A , B, and C
E. Review of source materials and technologies
F. Contacts/meetings with active technical persons, agencies, *etc.*
G. Evaluation of D and E
H. Identification of 1) successful methodologies and 2) deficiencies and short-comings
I. Synthesis of D, E, F, and G and formulation of initial recommendations
J. Report on findings and recommendations

TASK 2   Workshop on Mine Burial

A. Development of initial workshop objectives and plans
B. Selection of key technical persons to attend workshop
C. Development of final workshop objectives and agenda
D. Convene workshop
E. Report on workshop results and recommendations including identification of key technical issues and specialists to address the mine burial prediction deficiencies.

WORK COMPLETED

1)   Attended Technical Meetings at ONR with Program Managers Drs. Douglas Todoroff and Joseph Kravitz (November '99; December '99) to review specifics of project objectives, points of contact (POC) at US naval facilities, international interests, and goals.

2) Established contacts and attended Meetings in London with Dr. Robert Dolan (ONR, London liaison) and representatives from the United Kingdom, France, The Netherlands, and Germany. In the U.S. attended a Meeting with representatives from the Naval Research Laboratory, Stennis Space Center (NRL-SSC) to review NRL activities in mine burial. Attended a Meeting at ONR in Arlington, VA (June '99) with Drs. Douglas Todoroff and Joseph Kravitz to establish strategies for completion of the NATO Mine Burial Report. Mine Burial SG-31 Final Report Completed in June. The work included review, analysis, and extensive technical editing of the report.

3) Established points of contact and communications with naval facilities, universities, *etc*., including international contacts involved in mine burial. Visits with OPNAV 852, Pentagon, and U.S. Navy MCM personnel for discussion of International Programs, needs and requirements on mine burial problems, and international aspects of mine burial and exploratory mine warfare**.** Discussed various mine burial issues and Naval needs. Visited with Dr. Wally Ching, Presearch, Inc. Discussed mine burial activities of foreign countries where applicable. Emphasis was on cooperative US--Korean work. Meeting with Mr. Linsenmeyer, CSS, on mine burial issues.

4) Conducted extensive literature search of source documents (national and international). Relevant documents were obtained and reviewed, and a comprehensive reference list was developed. Also conducted an extensive review of source documents and records of important technical details of current research and applied technology related to mine burial.

5) Developed two (2) technical questionnaires on the Mine Burial issues: one for operational Navy mine warfare personnel, and another for science and engineering professionals conducting basic and/or applied research. These Questionnaires were sent out to numerous National and International contacts (naval facilities, universities, industry, and individuals). The returned Questionnaires have been reviewed and summarized.

6) Held Mini-Workshop with Europeans in London at the ONRIFO to review critical issues in Mine Burial. This Workshop was planned and organized in cooperation with Dr. Robert Dolan (ONR, London liaison).

7) Developed working contacts with COMMINWARCOM, Corpus Christi, TX; the Naval Post Graduate School, Monterey, CA; VSW, Coronado, CA; and several other naval facilities including those of New Zealand, Australia, Israel, Turkey, and others.

8) Developed preliminary outline for the Mine Burial Assessment (MBA) Workshop to be held by ONR in FY-2000. This is part of the MBA Final Report to be submitted to ONR.

10).Completed Draft of the Mine Burial Assessment Report. Submitted Draft to Dr. Joseph Kravitz, ONR.

IMPACT/APPLICATIONS

This work supports virtually all shallow-water coastal applications for U.S., Navy Mine Warfare, especially for Mine Burial and Mine Counter Measures. Specifically, this includes fleet aids in mine burial modeling, mine burial assessment, search and recovery, sonar applications, and mine neutralization. In addition, it provides information vital to amphibious warfare (AW). It finds further utility in dredging operations, underwater cross-shore and offshore construction, submarine recovery activities, coastal pollution control, and other applications.

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